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Title of Thesis: Development of Fluorescent OLED and Analysis of Integrated Optofluidic Lab-on-a-Chip Sensor

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Abstract

Optofluidics is a new branch within photonics which attempts to unify concepts from optics and microfluidics. Unification of photonics and microfluidics enable us to carry out analysis of fluids through highly sensitive optical sensing device. These optical sensing devices are contained within a microchip, wherein light is made to pass through analyte (fluids of few nanoliters). The interaction between light and fluid gives rise to highly sensitive diagnostic systems.

In this work the fabrication and performance characterization of a fluorescent green OLED for optofluidic applications is presented. The effect of thickness variation of hole injection (CuPc) and hole blocking (BCP) layers on the performance of fluorescent green organic light emitting diodes (OLEDs) have been studied. Even though these two organic layers have opposite functions, yet there is a particular combination of their thicknesses when they function in conjunction and luminous efficiency and power efficiency are maximized. The optimum thickness of CuPc layer, used as hole injection layer and BCP used as hole blocking layer were found to be 18 nm and 10 nm respectively. It is with this delicate adjustment of thicknesses, charge balancing was achieved and luminous efficiency and power efficiency were optimized. Such OLEDs with higher luminance can be monolithically integrated with other optical and fluidic components on a common substrate and can function as monolithically integrated internal source of light in optofluidic sensors.

In this work the analysis of a fully integrated optofluidic lab-on-a-chip sensor for refractive index and absorbance based sensing using fluorescent green organic light emitting diode (OLED) as a light source is also presented. This device consists of collinear input and output waveguides which are separated by a microfluidic channel. When light is passed through the analyte contained in the fluidic gap an optical power loss due to absorption of light takes place. Apart from absorption a mode-mismatch between collinear input and output waveguide also occurs. The degree of mode-mismatch, quantum of optical power loss due to absorption of light by the fluid forms the basis of our analysis. Detection of minutest change in refractive index and changes in concentration of species contained in the analyte is indicative of sensitivity. Various parameters which influence the sensitivity of the sensor are mode spot size, refractive index of the fluid, molar concentration of the species contained in the analyte, width of the fluidic gap, waveguide geometry. By correlating various parameters, an optimal fluidic gap distance corresponding to a particular mode spot size to achieve the best sensitivity for refractive index based sensing and absorbance based sensing have been determined.